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EUROPEAN PLANT PROTECTION ORGANISATION

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The Protection of Foodstuffs in Store

REPORT
OF THE STORED PRODUCTS WORKING PARTY

(Brussels, June 30 - July 3, 1953)

★

September 1953
PARIS
14, RUE CARDINAL MERCIER

THE PROTECTION OF FOODSTUFFS IN STORE

Report of the Stored Products Working Party

and

SURVEY OF THE POSITION
IN EPPO MEMBER AND CORRESPONDING COUNTRIES

EUROPEAN PLANT PROTECTION ORGANISATION

14, RUE CARDINAL MERCIER - PARIS

STORED PRODUCTS WORKING PARTY

(Brussels, June 30 - July 3, 1953)

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STORED PRODUCTS WORKING PARTY

Brussels, June 30 - July 3, 1953

AGENDA

1. *To discuss means whereby Governments might be made aware of the necessity of setting up suitable inspection and control organisations.*

2. *To discuss and draw up a Code of Practice of hygiene measures and of appropriate chemical treatments for stored foodstuffs on farms and in warehouses (e.g. residual sprays).*

3. *To discuss the possibility of deciding desirable standards, from the insect infestation standpoint, for grain carried in international transport, in order to make recommendations to FAO with a view to the adoption of such standards by all grain-exporting countries.*

4. *To discuss unsolved problems of general interest (fumigation of bulk grain stored on floors ; methods of admixture of insecticides with grain, etc.).*

A LIST OF MEMBERS OF THE WORKING PARTY APPEARS ON P. 2.

EUROPEAN PLANT PROTECTION ORGANISATION

Stored Products Working Party

REPORT

TO THE CHAIRMAN OF THE EXECUTIVE COMMITTEE

SIR,

1. The agenda of the Working Party will be found on the opposite page. Our discussions were limited to the subject of infestation of stored foodstuffs by *insects and mites.* We did not discuss rodents (rats, mice, etc.), moulds or fungi.

2. The losses caused by insect and mite infestation of stored foodstuffs are very serious. At the International Conference on Food Infestation which was sponsored by FAO and held in 1947, these losses for the world as a whole were estimated to be as high as 5 %. If damage by rodent pests were included, the estimated figure was put at 10 %. It is unlikely that losses of this magnitude occur normally in European countries, but very considerable damage is certainly occurring. In Federal Germany, for example, the annual losses of stored foodstuffs due to insect and rodent infestation are estimated at 9 % (in value about £35 million), and one insect alone — the grain weevil — is estimated to cause a loss of 2 % of stored grain. Further, apart from actual loss of food, infestation is detrimental to the maintenance of good food hygiene, and the presence of insect or rodent debris in processed food may, and does, cause its rejection by importing countries. These are national losses. At home, the manufacturer who unwittingly distributes packages of infested food, such as chocolates or dried fruit, suffers heavily both financially and in prestige.

3. Specialists in all countries are agreed that as the result of research into methods of control and the development of new techniques, much of the loss which at present takes place could be prevented. The Working Party accordingly passed unanimously the following resolution, which it trusts your Committee will authorise to be transmitted to European Governments :

> ***In the interest of European economy as a whole it is strongly recommended that the appropriate authorities in each country should examine critically the measures taken within their territories for the prevention of losses to stored food caused by the depredations of insects and other pests; compare these measures with those in force***

in other countries in Europe of which knowledge is available; and determine whether it is possible to improve the existing inspection and control organisation, or, if not already in existence, to create one. In view of the necessity for facilitating and not hindering international trade, the Working Party recommends that the co-operation of trade interests be sought in each country in devising standards and in other relevant matters.

4. Some Governments have already taken steps by way of legislation to provide for the control of stored food infestation; others have not. As it is desirable that, as far as possible, legislation should be uniform in all countries, the Working Party suggests the appointment by EPPO of a small Committee to examine the basic essentials of any form of legislation and to make recommendations for transmission to Governments. Legislation should be clear and simple, and lay specific responsibilities on those who actually handle the foodstuffs, such as warehouse-keepers and processers. Owners of goods and those who trade in them but may never see them should have some legal liability placed upon them, but this would normally occur through their commercial relationship with the warehouse-keepers or other custodians of the goods.

5. Countries importing foodstuffs should send to the countries of export reports on the sanitary condition of the consignments received. This is regularly done by the United Kingdom authorities, who have been able in this way to draw the attention of Canadian exporters (for example) to infestation in shipioads of wheat which were apparently clean at the time of export. Further, the inclusion of « pest free » clauses in commercial contracts is a good way of ensuring clean products. A maize consignment was shipped from East Africa to the United Kingdom on a contract providing *inter alia* for freedom from live weevils ; weevils were found, and the seller suffered a penalty of £1 per ton on the consignment of 3000 tons.

6. In the resolution incorporated in para. 3 above, reference is made to cooperation with trade interests. This is most important from every standpoint. If Governments are to be persuaded to establish control organisations and inspection services, the support of the traders in foodstuffs must be obtained; the regulations must be framed in cooperation with the trade, and the function of the inspection services must be not only to see that regulations are observed but to give technical advice to food handlers so that they are able to comply with them.

7. In preparation for the meeting of the Working Party, an enquiry was sent out by EPPO to European Governments, designed to secure information on the form of organisation now existing in the various countries for controlling infestation in stored foodstuffs and on the principal pests attacking them. The replies received are of general interest and form Appendix II to this report, which also includes some relevant information which had previously been supplied.

Treatment of Stored Foodstuffs on Farms and in Warehouses

8. The Working Party discussed the possibility of drawing up a Code of Practice of hygiene measures and appropriate chemical treatments for stored foodstuffs on farms and in warehouses. It decided that it was impossible to formulate a detailed Code applicable to all the conditions met with in Europe. Nevertheless, it agreed on certain important basic principles, relating particularly to the storage of food in warehouses, silos and other types of grain stores, to flour mills, ships' holds and railway waggons. As regards chemical methods of control, these change as new techniques are developed, but attention is drawn to certain measures which are believed to be the most outstanding. These relate to fumigation facilities and fumigants; to the practice of incorporating dusts, either inert or insect-

icidally active, with grain; to spraying and to atomising. The recommendations of the Working Party on these various matters are printed as Appendix IA to this report (cf. p. 10).

Grain Carried in International Transport

9. The Working Party considers that infestation standards for home-produced and home-consumed grain should be decided by the countries themselves, but that for grain which passes from one country to another there should be an international infestation standard, agreed between Governments, and recommended for adoption by all grain exporting and importing countries. This international standard can only be laid down in the light of experience, and it is suggested that Governments should be advised to carry out examination of grain cargoes by recognised methods over a trial period of six months from the receipt of this report.

The governing factors are :

a. The objective should be a total absence of insects and the least practicable number of mites.

b. There should be a general examination of the cargo to determine the kinds of insects and mites present.

c. Samples taken in an approved manner should be examined to determine the number of free-living insects and mites present in the samples.

d. A carbon dioxide (CO_2) production test should be applied. This test derives from the fact that grain gives off carbon dioxide more slowly than animal matter, so that the presence of the larvae of insects or mites, which would otherwise remain undetected, is revealed, as is also the degree of infestation.

10. As regards the method of sampling, and the classification of samples from the standpoint of infestation, the Working Party suggests that the system applied in Federal Germany (cf. p. 12) might be adopted during the experimental period of six months, or alternately that participating Governments should apply their own standards, in the hope that at the end of the period it may be found possible to recommend a satisfactory standard for universal adoption.

11. Details of the methods which might be adopted in the examination of grain in ships, and a list of the insects and mites to be taken into account, are printed as Appendix IB to this report (cf. p. 12).

Unsolved Problems of General Interest

12. The Working Party discussed several matters : the fumigation of bulk grain stored on floors; methods of admixture of insecticides with grain; the use of high frequency electric currents in the control of infestation. A summary of these discussions is printed as Appendix IC to this report (cf. p. 14).

13. EPPO should serve as the European centre for the collection and distribution of information on stored products infestation and methods of control. A short annual report on new developments or particular experiences of infestation in the various countries would be valuable. It is recommended also that European Governments be asked to communicate to EPPO information on all work relating to the toxicity of the synthetic organic compounds — insecticides and fungicides — used for the preservation of foodstuffs in store,

together with the relevant observations of the various official services : public health, veterinary, agricultural and phytopharmaceutical.

14. It is hoped that the Executive Committee will see its way to convene a further meeting of the Working Party in 1954. Questions which could then be usefully discussed might include (a) the position regarding legislation governing the protection of foodstuffs in store; (b) the equipment of the various countries in regard to silos, fumigation plants, spraying, dusting and fogging machinery; (c) the use of insecticides, especially new products, and the method of incorporation with cereals and other stored foods; (d) sampling and control methods; (e) high-frequency treatment of infestation; (f) insect-proof packaging.

15. The Working Party met at the offices of the Belgian Ministry of Agriculture in Brussels. The last day, July 3, was taken up by a visit to the Government Entomological and Phytopharmaceutical Stations at Gembloux, to see the research work in progress at those centres. We were welcomed on behalf of the Minister by M. F. Mat, Director-General for Agriculture, and we record our grateful thanks to the Ministry for the warmth of our reception and for the extremely efficient organisation of all the arrangements.

We have the honour to be, Sir,

Your obedient servants,

Signed on behalf of the Working Party:

V. E. WILKINS
(*Chairman*)

September 1953,
14, rue Cardinal Mercier, Paris.

APPENDIX I

A. Measures of Hygiene and Appropriate Chemical Treatments for Stored Products

— Warehouse Storage
— Storage of Grain in Silos
— Bulk Stores
— Disinfection of Mills
— Goods in Transport
— Fumigation in Silos
— Fumigation under Fabrics
— Fumigation in Ships
— Dusting
— Spraying
— Atomised Insecticides

B. Infestation Standards for Grain Carried in International Transport

— Sampling
— General Examination
— Carbon Dioxide Test
— Main Species

C. Infestation Problems of General Interest

— Admixture of Insecticides with Grain
— Treatment of Bulk Grain with Phosphine
— Use of High-Frequency Electric Currents

APPENDIX I

A. *Measures of Hygiene and Appropriate Chemical Treatments for Stored Foodstuffs*

1. Warehouse Storage

In order to prevent, or to minimise, the development of insect infestation occurring in foodstuffs held in warehouses, good warehouse practice is essential.

The basic principles are good hygiene; attention to ventilation, humidity and methods of stacking; the proper use of dunnage, and the segregation and rotation of commodities.

Of these the most important is good hygiene, and it is the one most liable to be neglected. When a stowage or part of a stowage becomes empty, the ceiling, walls and floor should be swept, the sweepings should be removed, and if possible any dust left should be collected with a vacuum cleaner. Empty sacks or rubbish of any sort should be removed and spillage should be swept up as soon as possible after handling operations are complete.

Warehouses should not be *artificially heated,* since insect increase accompanies an increase in temperature.

They should be *weather-proof.* Dampness encourages the development of insects and, more especially, mites.

Goods should be stacked well away from walls and adequate alleyways provided for inspection purposes. Where there is any danger of the floor being damp, bagged goods should be stacked on dunnage to protect them from direct contact with the floor.

Different commodities and different shipments of the same commodity should not be in contact with one another.

2. Storage of Grain in Silos

Preventive mechanical treatments are:

a. Screening, to eliminate the free living insects and the dust.
b. Drying, to reduce the water content, in order to prevent the development of the pests.
c. Movement of the grain, to disturb the pests in their process of development.
d. Cooling of the grain if the storage temperature is too high, thus discouraging insect development.

It should be noted that (c) and (d) are sometimes dangerous, since the movement of the grain encourages spread of the infestation, while an extremely high temperature stops development. These points do not apply if the grain has been treated with gas.

There should be continual inspection of the grain from the standpoint of temperature and water content, a rise in the former often being an indication of infestation.

3. Bulk Stores

Grain held in bulk stores should be freed of dust. The stores should be clean, and the floors and walls without crevices, and preferably of concrete. The problem of filling cracks in wooden granaries is a difficult one, but is of great importance and should not be neglected.

4. Disinfection of Mills

All mills, both large and small, should be regularly disinfected with HCN or another gas. This treatment is effective for buildings, machinery and partly for pipes, which should have very special attention. They must be perfectly clean. All dust and debris of grain and flour must be eliminated.

It is necessary, after fumigation has taken place, to take steps to ensure that insects do not get into the flour.

The construction and maintenance of stores must be such as to limit to the utmost the introduction and development of pests.

5. Goods in Transport

Ship cargoes should be inspected and if necessary disinfected. Holds should be cleaned, inspected and if necessary treated before a new cargo is loaded. So far as possible, cargoes should be kept separate, to avoid the risk of cross infestation. The spaces behind bulkhead boards and below bilges are especially liable to carry infestation, and should receive special attention.

Goods carried in *railway trucks* should be inspected prior to loading. If infestation is discovered, trucks should be disinfected immediately after they have been unloaded. They should, in any case, be well cleaned before and after any other foodstuffs are carried. A powerful vacuum cleaner is useful for this purpose, but spraying or smoke treatment is advisable in addition.

6. Fumigation in Silos

For the fumigation of cereals in closed circuit silos a toxic gas (methyl bromide, ethylene oxide, etc.) is passed through the grain for a given period. Silo bins full of grain may also be fumigated with carbon tetrachloride, sprayed on to the top of the grain. Adult insects, larvae and eggs, even inside the grain, are completely destroyed by these means.

Ethylene oxide should be used solely for edible and not for seed grain. Methyl bromide may damage or delay the germination of some cereals and oilseeds.

It is recommended that all ports of entry and exit of grain be equipped to carry out fumigation treatment, as it is the only means of obtaining completely uninfested grain.

7. Fumigation Under Fabrics

Stacks of bagged commodities can be effectively disinfected *in situ* (i. e. in warehouses or in the open air) by fumigation (e. g. with methyl bromide) under gasproof sheets. Very large stacks can be covered by a number of such sheets, the edges overlapped and rolled together to make a gas-tight seal. The sheets are held to the ground by sandbags or some other suitable method.

8. Fumigation in Ships

A really suitable method for the fumigation of *grain in ships* has not yet been discovered.

9. Dusting

Dusting can help in preventing infestation, dusts having a chemical action being preferable. For instance, synthetic insecticides, DDT and Lindane can be mixed with grain or used to disinfect sacks.

There is at the present time no general agreement between countries whether it is desirable to incorporate insecticidal dusts in food grain, though all are agreed as to its value for the protection of grain intended for seed purposes only.

The various mineral powders which have been recommended are of varying effectiveness (lime, magnesia, alumina) and may be dangerous (silica powders or colloidal silicas).

10. Spraying

Residual sprays based on DDT or Lindane are recommended for use on walls, floors, and on well-packed articles, but should never be used on unprotected foodstuffs. Under certain conditions, pyrethrum sprays will remain toxic to pests for several weeks and these can be used not only on walls but on unprotected foodstuffs.

For spraying walls and floors, when there is no likelihood of mould developing, wettable powders in water should be used. Where water cannot be used, for instance on packed commodities, a kerosene base should be employed.

Space sprays of pyrethrum or a mixture of pyrethrum and piperonyl butoxide, in kerosene, may be used above grain in bulk, as a preventive against the development of infestation, especially that which may arise from moths. Heavy film spraying of pyrethrum or pyrethrum-piperonyl butoxide mixtures can be used on bulk grain, and this film will remain toxic to moths and caterpillars for several weeks.

Commodities should be inspected daily and sprayed when necessary.

II. Atomised Insecticides

Insecticides may be atomised in a number of ways, e. g. mechanically or by heat, to form an aerosol.

Such aerosols are effective in destroying exposed insects, e. g. in warehouses, empty silos, ship holds, railway waggons, etc. It must be remembered that aerosols do not behave as gases, and have almost no power of penetration. Thus insects are completely protected from the effects of aerosols by a layer of sacking or a little straw or dust. It is therefore essential that thorough cleaning should precede the use of insecticidal aerosols. It is claimed that the aerosols, on settling, leave a toxic film, but this is of little effect in comparison with residual sprays.

B. *Infestation Standards for Grain in International Transport*

In paras. 9 and 10 of its report the Working Party suggests that for a trial period of six months Governments should examine cargoes of imported grain, so that in the light of the experience gained it might be possible to formulate a standard method of sampling and examination which could be recommended for universal adoption by grain-importing countries. The sampling method outlined below has been introduced in Federal Germany. Either this method, or one devised by Governments participating in the scheme, should be used during the trial period, and it is hoped that the results, with comments, will be communicated to EPPO for further action.

I. Sampling

For a full cargo of grain samples should be taken from each hold in course of discharge. A 0,5 kg. sample should be taken for every 20 tons of grain. Samples from each hold should be bulked, and a 6 kg. average sample should be divided into 2 portions, each portion being examined separately. The samples from each hold should be examined separately, and an average for the cargo determined from the results of the inspection of each hold. The provisional classifications of infestation proposed are:

a. *Insects*

1. No living insects.
2. Very light : Not more than 2 insects per 3 kgs.
3. Light : » » » 4 » » 3 »
4. Medium : » » » 10 » » 3 »
5. Heavy : Over 10 » » 3 »

b. *Mites*

1. No mites.
2. Light : 20 mites per kg.
3. Medium : 40 » » »
4. Heavy : 60 or more » »

The same method of sampling should be applied to grain in bags.

2. General Examination

The general examination of the cargo should take place at intervals during discharge of ships, and particularly before unloading commences. The general examination is intended mainly to reveal the presence of insects such as moths and caterpillars which are unlikely to be detected by sieving of samples.

3. Carbon Dioxide Test

The carbon dioxide production test* should be used as a routine for *all* samples, but if this is not possible, it should particularly be employed for the testing of:

a. Samples where sieving and general examination show no insects;

b. Samples where insects are found at the general examination but not at the sieving.

It should be noted that the conduct of the CO_2 test makes it essential for the water content of the grain to be determined, and special samples in sealed containers are necessary for this purpose. Samples for the CO_2 test must *not* be in sealed containers but in ventilated ones. It is also desirable for the temperature of the grain to be determined at the time of inspection.

4. Main Species

The insects and mites normally to be taken into account in the general examination of grain in ships and of samples are limited to the following species :

Coleoptera

Calandra granaria
Rhizopertha dominica
Laemophloeus spp.
Tenebroides mauritanicus
Tribolium castaneum
Tribolium confusum
Calandra oryzae
Oryzaephilus surinamensis
Trogoderma granarium
Latheticus oryzae

Lepidoptera

Sitotroga cerealella
Plodia interpunctella
Ephestia spp.

Acarina

Tyroglyphus farinae
Glycyphagus spp.
Tyrophagus spp.

(And others which are not predators or parasites on insects or mites.)

Note 1. Any other species occurring in exceptional numbers should be noted and taken into account in determining the grade.

Note 2. Countries may add other species to the list for the purpose of making standards for use inside the country.

(*) *Detection of Insects by Their Carbon Dioxide Production*, by R.W. Howe and A. Oxley (London, Her Majesty's Stationery Office, Kingsway, W.C.1., 1952, 1/- net).

C. *Infestation Problems of General Interest*

(SUMMARY OF DISCUSSION)

I. Admixture of Insecticides with Grain

Delegates of the countries represented on the Working Party were requested to furnish information as to the present position in their countries regarding the admixture of dusts, both inert and insecticidal, with grain.

Algeria

It is forbidden to add insecticide powder to cereals in Algeria.

Belgium

It is also forbidden in Belgium, where no mineral matter may be added to cereals. DDT, though not a mineral, is nevertheless forbidden.

Denmark

For nearly 10 years 2 % DDT has been used, plus pyrethrum for quick action. (5 % DDT is used in *Sweden*.)

Denmark uses 100 grams per 100 kgs. of grain, mostly for farm use and only rarely in old-fashioned warehouses. It is not used for grain for export, but mostly for animal feeding stuffs treatment. The amount treated is from 15,000 to 80,000 tons a year (80,000 is exceptional) according to the heat of the summer. Experiments done on Government experimental farms have shown that the treated grain is safe for pigs, chickens, cows and horses.

Federal Germany

Since 1941 the use of powder containing silica has been forbidden because of the danger of silicosis. There are no special regulations in regard to insecticides such as DDT and Lindane, but these are officially recommended only for the disinfection of small quantities where no fumigant can be used. Cereals must be aspirated after treatment and mixed with an equal quantity of untreated cereals (that is, untreated in this way). It is realized in Germany that this practice is not always faithfully carried out by farmers. Toxicity is being studied in several State institutes and the question of residues is being studied at the Biological Institute in Brunswick. Recently the method of analysis of BHC has been changed; it is not sufficient to determine only the quantity of chlorine, because in addition to the chlorine resulting from the addition of the powder there will also be certain quantities from the cereals themselves. A new method is now being employed which avoids this error. This new method is being applied for the detection of BHC in flour and bread. Besides, an improved method for the detection of DDT in flour and bread has been developed.

Flour originating from dusted grain was examined by application of these methods. After six months of storage the grain contained an average of 1-2 ppm BHC or 6-8 ppm DDT respectively, independent of the kind and method of handling of the grain. Neither BHC nor DDT could be found in bread, consequently the content is below 0.2 ppm.

The considerable decrease of BHC in bread is caused by the high temperature of the baking process which is accompanied by water evaporation. The decrease of DDT is probably also caused by the high temperature of the baking process and a possible decay of the chemical.

After nine months of storage the content of BHC in the grain declined to 0.2-1.5 ppm and that of DDT to 3-7 ppm.

It is emphasised that these results, obtained by using the latest methods of analysis, are preliminary and must be confirmed by further experiments.

Dusting chemicals containing pyrethrum and piperonyl butoxyde have been used in Germany only recently. Practical experience, particularly regarding the duration of effect, is not yet available.

France

In France Lindane is authorised. The proportion used is 0.5 g. per 100 kgs. It is used in the form of a commercial powder of which the content is usually 6 % Lindane. The system, which is not yet widely adopted, is used for the treatment of cereals which are to be held in storage for a long period.

Netherlands

The admixture of dusts with cereals is forbidden.

Switzerland

The admixture of DDT and Lindane with foodstuffs is forbidden. Special permission may, however, be given for treatment of a given stock of cereals with DDT, but this has to be done under the control of a State chemist and the cereals have to be washed before milling.

United Kingdom

The admixture of insecticides with grain is not forbidden by law in the United Kingdom but it is not officially encouraged. Generally speaking, only experimental treatments have been carried out, and the results have not been favourable to the use of this method, particularly as great difficulty has been found in mixing insecticides evenly with large quantities of grain. It is considered that other methods are more suitable for small scale treatments. BHC/Lindane dusts have, however, been used for the surface treatments of bulks of grain, and it is proposed to carry out experiments with piperonyl butoxide-pyrethrum. The use of dusts for the protection of malt against *Trogoderma* is of special interest.

No objection is raised to receiving grain from abroad which has been *lightly* treated with dusts. Maize is received from East Africa treated with 1 ppm BHC, and also beans from E. Africa treated with Lindane.

The recommended maxima not to be exceeded in the United Kingdom are :

DDT : 7 ppm.

Lindane : 2.5 ppm (of gamma isomer).

It has been found experimentally that if DDT is applied so as not to exceed 7 ppm, the concentration is inadequate to be effective against insects. The limit of 2.5 ppm for gamma BHC, while effective against *Calandra granaria,* is only partially effective against *Tribolium,* and useless against *Oryzaephilus.*

It is unlikely that the mixing of insecticides with wheat will become a common practice in the United Kingdom, because there are strong public objections to the mixing of chemicals of any kind which are likely to find their way to flour and bread. Even if the Government services wished to authorise the mixing of DDT and Lindane they would be ill-advised to do so for that reason.

II. Treatment of Bulk Grain with Phosphine

In *Federal Germany* gas treatment of bulk grain is done with phosphine (phosphuretted hydrogen) contained in paper bags which are mixed in with the cereals. Phosphoric acid gas is given off in eight days, because of the humidity of the grain. To hasten the process a crystalline salt can be added. It is a simple process, and there is complete destruction of all stages of weevils and other insects.

The stacks are covered with sheets of paper to prevent the gas escaping too quickly.

There are strict rules governing the procedure, because of the risks involved. Specially trained personnel is employed and a Government permit is required. Surrounding rooms must be evacuated. During 15 years no serious accident has occurred. Usually no mask is necessary because of the quickness of the operation.

The process would not be suitable in hot climates where the bags might ignite. If the grain temperature rises to 30-35°C special paper bags must be used, as the ordinary bags might blow up.

The process can be used in silos as well as in granaries and warehouses. The paper bags are inserted as the grain enters the silo and someone inside the silo ensures that they are adequately distributed. The system can also be used on farms when it is possible to empty adjoining rooms.

It has been found that the movement of the grain does not tear the paper bags. These are re-gathered in sifting. The aeration of chambers is not necessary during or after application. The bags have been analysed by the Public Health authorities, and there is no great danger of toxic residues because the bags are removed. One million tons of grain have been treated, and there is no record either in experiment or in practice of any subsequent toxic effects.

Recently there have been trials to simplify the process by using phosphine in tablet form instead of in bags. The tablets are distributed by spears throughout the stacks. In decomposing they give off phosphoric acid. Trials have not yet been completed, but the residues have not been found harmful from a health standpoint.

Cf. also p. 41.

III. Use of High-Frequency Electric Currents

In *Belgium,* preliminary experiments have been carried out at Gembloux with high frequency currents for weevil destruction. It has been found that the temperatures obtained with high frequency currents, even if high enough to kill all insects and their larvae and eggs, were still below the temperatures which would affect the milling qualities of the grain; i.e. the critical temperature for the insect does not affect the grain.

The method could not be generally used because it is too expensive, but might be of use for the treatment of small quantities of a number of products, e.g. packed cocoa powder, spices, cream flours for soups, oat flakes. The method is already used for treating sacks in America.

Mites are the most important problem in Belgium. The manufacture of oat flakes, for example, is threatened because of mites. It is known that the mites were not coming in with the oats, because the temperature necessary for the manufacture of flakes would kill them. The question was, when do the flakes become infested ? It might take place in grocers' shops, but it is suspected that it took place at the factory before packing. Although the factories are disinfected twice a year, there is continuous re-infestation. If only a few eggs get into the flakes they will give rise to mites which will reproduce very rapidly. Cellophane packets are not airtight and infestation can spread. An economic method of high frequency current treatment of the packets would be a solution.

In *Switzerland,* experiments have been carried out by the Federal Wheat Board in collaboration with a firm of electrical engineers. The results were interesting. The method might be economic if there were facilities for treating large quantities.

The *United Kingdom* delegate referred to a recent publication which provides a summary of knowledge of the high-frequency control of infestation. The author was Morris Thomas and the pamphlet was published by the Electrical Research Development Association, Greenford, Middlesex.

APPENDIX II

Pests of Stored Products in Europe

A survey based on replies received from EPPO Member and Corresponding Governments to an enquiry made in April 1953

The enquiry consisted of the following three questions :

A. **What steps are at present taken to avoid losses to stored foodstuffs from insect pests? Are the facilities of an advisory nature only, or based on inspection? Is there legislative provision for the control of stored foodstuffs?**

B. **Please supply a list of the principal stored food pests in your country, together with particulars of** (a) **relative importance,** (b) **incidence,** (c) **commodities infested,** (d) **storage conditions.**
(For Mediterranean countries only : Does *Calandra oryzae* **and/or** *Sitotroga cerealella* **infest grain** in the field **in your country?)**

C. **Please supply particulars of instances where control of stored pests is difficult (e. g. fumigation of bulk grain stored on floors ; methods of admixture of insecticides with grain ; etc.).**

Reporting countries and territories are divided into two geographical groups : " Northern " and " Mediterranean ". Within each group, they are listed according to geographical proximity. For reasons of convenience, France appears only in the " Northern " group.

A. *What steps are at present taken to avoid losses to stored foodstuffs from insect pests ? Are the facilities of an advisory nature only, or based on inspection ? Is there legislative provision for the control of stored foodstuffs ?*

NORTHERN GROUP

Iceland

ORGANISATION. In Iceland there is little loss of stored foodstuffs from insect attacks, and no routine control measures are applied. If insects are found in food products, either at the port of entry or in warehouses, specialists from the University Research Institute and/or the Health Officer at Reykjavik are notified and take the necessary steps to deal with them.

Ireland

LEGISLATION. Under the Emergency Powers (Storage of Grain) Order, 1942, grain stores may be inspected by officers of the Minister for Agriculture. Occupiers of grain stores may be directed to clean (including fumigate) stores and equipment and to remove or render innocuous any case of contamination or deterioration. Storage of grain in unsuitable premises may also be prohibited under the Order. Grain storage premises are inspected from time to time and incoming cargoes of grain are inspected at the time of arrival.

During 1952, 82 ocean cargoes comprising wheat, barley, maize, etc., were examined at their unloading berths by trained officers. In 9 of these cargoes slight weevil infestation was found. In some cases the weevil died in the colder climate of Ireland, and in others fumigation by cyanide was carried out.

Active vigilance is maintained at all grain storage points, so as to arrest immediately any possible development of infestation.

United Kingdom

ORGANISATION. Since 1940 an organisation, first in the Ministry of Food and, since 1947, in the Ministry of Agriculture and Fisheries, has existed for the inspection and control of insect and rodent infestation in stored food. Its work has been facilitated by Government ownership and storage of much of the country's food supplies, which has made it possible for inspection and control action to be carried out as a service by one Government Department for another.

The reversion to private trading in nearly all foodstuffs which will occur in 1953 will make control of storage pests commercially and technically more difficult.

At present the official inspection and control organisation for insect pests forms part of the Infestation Control Division of the Ministry of Agriculture and Fisheries in England and Wales and the Infestation Branch of the Department of Agriculture for Scotland in that country. The following remarks deal only with England and Wales.

In addition to an administrative and scientific organisation at Headquarters (Tolworth, Surrey), there are some 44 expert inspectors (mainly graduate biologists and chemists) stationed at the ports of London, Liverpool, Hull and Bristol and at other principal towns. Although their main work is the care of Government-owned food, they also maintain an advisory service for the food storage, handling and processing industry generally and are responsible for the technical aspects locally of the application of the provisions of the Prevention of Damage by Pests Act, 1949 (see below). So far as advice is concerned it is a cardinal point of technical policy not to give advice without prior inspection, except in minor household cases. Regular visits are paid to all warehouses, food factories, etc., in the country and owners are encouraged by such visits and by written matter to carry out known effective measures of sanitation and prevention and control of insects and mites. An important aspect of this work is the inspection during discharge of almost every cargo of food arriving in the country; arrangements can be made for immediate insect control where necessary before the goods and their insects are sent away from the port. Recommendations are made to shipmasters where residual infestation in the holds of ships requires treatment.

The Ministry has a small staff of workmen who carry out cleaning, spraying, insecticidal dusting, preparation of warehouses for fumigation, etc.; these men are principally employed in the care of Government food stocks. Fumigation is normally carried out by commercial servicing companies, to the specifications of the Ministry.

LEGISLATION. Under the Prevention of Damage by Pests Act, 1949, there is a duty laid on the custodian of stored food to notify the Minister of Agriculture of infestation which is defined as " the presence of rats, mice, insects or mites in numbers or under conditions which involve an immediate or potential risk of substantial loss of or damage to food ". Infestation of road and rail vehicles, barges and of empty food containers (e. g. sacks) is also notifiable. Although infestation of cargo and empty holds of ocean-going ships is notifiable, special administrative arrangements have been made regarding the inspection of ships to avoid delay in turn-round.

Certain exemptions from the strict notification procedure have been made. Action against persons selling infested food can also be taken under the Food and Drugs Act, which is administered by the Ministers of Food and Health.

France

ORGANISATION. The *Office national interprofessionnel des céréales* gives advice to those concerned with the storage of foodstuffs. The Plant Protection Service also acts in this capacity, and in many cases prescribes the methods of treatment necessary, or ensures the disinfection of infested foodstuffs in specialised stations.

The Plant Protection Service is advised when mills are to be disinfected.

LEGISLATION. Except the legislation concerning imports, there are no regulations providing for phytosanitary control of foodstuffs either privately owned or for military uses, and there is no law requiring treatment in the case of insect infestation.

Belgium

The control organisation consists of :

- A central control service (*Répression des fraudes*) at the Ministry of Agriculture ;
- The Government Entomological Station at Gembloux, where a specialist assistant investigates technical problems ;
- A field service of 10 inspectors who report infestations, collect specimens of the pests and of the foodstuffs attacked, and instruct those concerned as to the treatments to be carried out, after consulting the Central Service and the Gembloux Station. These inspectors are also responsible for controlling the trade in seeds, fertilisers, animal feeding stuffs and phytopharmaceutical products.

LEGISLATION. The Government Order of November 20, 1946, places the responsibility for dealing with infestation on the owners of the infested foodstuffs. Also the owners or occupiers of transport or stores intended for foodstuffs must report the presence of any pests to the central Service, which gives them any necessary advice and help. If the necessary steps are not taken by those responsible, the Ministry of Agriculture can step in and do the work, either direct or through commercial firms.

A further Order dated November 21, 1946, set up a National Committee for the Protection of Cereals and Stored Foodstuffs, to consider all relevant matters.

Netherlands

LEGISLATION. The Food Supply Decree of 1940 stipulates the responsibilities of people concerned in the handling of foodstuffs. Every one who, for whatever purpose, has to do with food products, is obliged to pay such attention to these products as can reasonably be expected in the prevailing circumstances. In this Decree the Government is given power to issue instructions as to the storage of products. Transgression of this Decree can involve a fine of up to 24,000 guilders (over £ 2,200) or one year's imprisonment. The Decree makes it possible for instructions to be given both to those who store products on Government account and to the owners of such products.

ORGANISATION. The responsible Government department is A. V. A., a branch of the Ministry of Agriculture with offices at the ports of Amsterdam and Rotterdam. There are respectively 20 and 30 supervising officers attached to these offices who are in charge of food inspection in these ports. The actual inspections are carried out by cereal trade experts who are under the supervision of the above-mentioned officers. These men report to the port offices. They give information concerning the tonnage, origin, quality, moisture content, temperature and infestation of cargoes. The officers of A. V. A. take and seal up samples in case disputes arise. If necessary the cargo is dried, fumigated etc. or otherwise treated. Supervisors are equipped with sampling spears and thermometers. Moisture content is estimated on the spot in

the usual way. Samples are often sent for inspection to Government laboratories. Identifications of stored product insects are carried out by the Plant Protection Service, since A. V. A. has no laboratory facilities. The Plant Protection Service also advises A. V. A. on technical problems concerning fumigants and fumigation. Since 1952 the Plant Protection Service has an experimental vacuum fumigation plant of 3 cubic meters capacity.

STORAGE. There is a pool of warehouse owners who arrange among themselves the available accommodation. The A. V. A. can order the storing of Government products in warehouses separate from other products and free from rodent and insect infestation. The warehouse owners are responsible for any deterioration of the products. The A. V. A. contracts for storage include the following provisions :

- Stores shall be clean and well ventilated. They shall be equipped with screens and air blowers.
- The storekeeper is bound to take proper steps for the extermination of rodents.
- Between the products and the outer wall a space of about 2 ft. shall be left.
- Regularly, depending on quality and season, the wheat has to be screened and cleaned from dust in order to prevent infestation by beetles, mites, mould and heating.
- Sweepings shall be removed and on no account be stored together with sound products.
- Wheat that has not been artificially dried shall not be stored higher than five feet.

For wheat stored in sacks it is stipulated :

- The sacks shall be carefully cleaned before use.
- Depending on the quality of the wheat, the sacks shall be stacked in an upright position, but never higher than 5 sacks. Between the top sack and the ceiling a space of about 2 ft. must be left.
- Between the rows of sacks a space of 6 inches should be left, whereas between every 6 rows a space of about 2 ft. shall be left.

In order to prevent any possible cross-infestation between different consignments, the A. V. A. can select the warehouse space to be used. They can also order the cleaning of stored products which they consider to be infested. If the owner does not comply with this order, instructions can be given for the stores' disposal.

Farmers are encouraged to thresh and sell their grain as soon as possible after harvest. As a result of the present situation, the demand for home-produced grain is very much greater than before the war and therefore there is little storage on the farm.

EQUIPMENT AND METHODS. Control of infestation is carried out in some privately operated warehouses in the ports by installations belonging to the owners of the warehouses. There are a number of firms who specialise in cleaning products. Also the municipality of Rotterdam possesses a cleaning and gassing plant.

Some compartments of the silos at Rotterdam and Amsterdam have a circulatory system for fumigation. A partial vacuum is used for mixing the gas and air. The gas is kept in continuous circulation through the compartments. Methyl bromide is generally used.

Fumigation of infested bulk grain stored on floors is carried out when no fumigation plant is in the direct neighbourhood. In most cases this task is carried out by specialised private firms. Here again methyl bromide is used.

Municipal disinfection services and some privately owned companies are equipped with gas chambers, some being on the vacuum principle. HCN and methyl bromide are commonly used. These chambers have also been used for fumigating cargoes. Skilled operators are always employed. A law of May 6, 1922, stipulates the technique of fumigating and the preparations to be used. Only privately owned companies having Government permission can operate fumigation plants or carry out fumigation of bulk grain.

Sprayings with pyrethrum preparations are frequently employed for cereals and cereal products. Empty warehouses are now mostly treated with lindane preparations.

Mechanical cleaning of stored products is frequently carried out. The cleaning apparatus is composed of a number of strainers of different mesh and also suction cleaners. In this way certain silos can pre-clean 100 tons per hour. The cereals are discharged pneumatically, and distributed to the compartments by conveyor belt (200 tons per hour). Easy movement from one compartment to another is possible by conveyor belt. This enables grain to be kept in good condition.

Some silos have central electrical control of compartment temperatures, enabling a continuous check to be made on heating. This is of particular importance in the storing of home-grown cereals, which have a high moisture content.

In both Rotterdam and Amsterdam the silos of warehouse owners have their own sack cleaning and repairing departments. There are in addition firms specialising in this work.

Saar

LEGISLATION. In the Saar an order dealing with the control of grain weevil is in force. According to this Order infestation by *Calandra granaria* must be notified to the Plant Protection Services of the Saar Chamber of Agriculture, which advise on methods of control. The owners of stores must allow the treatment to be carried out and give all necessary assistance and information. Non-compliance can be punished by fine or imprisonment. Inspection of stores and mills takes place only when infestation has been notified, and the appropriate control measures are then recommended.

Calandra granaria has spread in the country since June 1950, when a heavily infested consignment of 35 tons of maize was imported. Police inspections organised by the Plant Protection Service have led to the discovery of 38 outbreaks in stores, mills and farms. Subsequent inspections have shown that the control measures that were immediately applied were fully successful. Since the infested maize was mainly sold in small lots to poultry farmers, not all the outbreaks were discovered. The notifications that keep coming in show that weevil infestation is still quite heavy in the Saar. It is usually introduced into the mills with the cereal crops and spreads from there, often through sacks that have not been disinfected. Unnecessary storing of cereals (especially in small farms) contributes to the spreading of the weevil. The stores of wholesale dealers in food and fodder are generally up to normal standards of hygiene. It is in the interest of dealers to watch the cleanness of their stores.

METHODS. The following measures are recommended : washing the walls of stores with Grodyl-Neu ; treatment of sacks by contact insecticides or by heating ; treatment of seeds or fodder grain with special products (such as Geigy 33 (DDT), Gesarol 10 or Sitox). The fumigation of infested mills is compulsory.

Switzerland

ORGANISATION

Cereals for breadmaking. All cereals intended for breadmaking are imported (foreign wheat) or taken in charge (home-produced cereals) by the Federal Wheat Board, and remain under its control as long as the goods are stored in its depots. Inspectors are responsible for looking after these stocks. If they become infested, the case is submitted to an expert who decides what steps should be taken.

In the case of stocks in warehouses, the cereals are sent to a mill for immediate milling, or to a silo for fumigation with methyl bromide (Gas S.). The empty depot is then sprayed with an insecticide — pyrethrum or a mixture of DDT and Hexa.

Infested stocks in silos are fumigated *in situ* with Gas S., all the Government-owned silos in Switzerland being equipped for this treatment.

Apart from this, the Federal Law relating to the nation's wheat supplies puts on the owner of each flour-mill the obligation to store a supply of wheat proportionate to the quantity it uses. This wheat is the property of the mill, which is responsible for its preservation. Of the private silos in Switzerland, forty are equipped with fumigation plants ; the remainder can be fumigated by a mobile plant.

On arriving at the European ports, foreign wheat which has been bought by the Government for breadmaking is inspected for quality by representatives of the Federal Wheat Board. If there is insect infestation, the Board prescribes the measures to be taken.

Coarse Grains. The importation of coarse grains is subject to no control by way of legislation, and they thus serve as a constant source of reinfestation of the country.

Other stored foodstuffs (rice, cocoa, etc.). The same thing applies. The protection of the stocks is left entirely to the owners.

Austria

LEGISLATION. There are no regulations in Austria providing for the inspection of stored foodstuffs, of imported or exported cereal products. Under the 1948 Plant Protection Law (*Bundesgesetz vom 2.6.1948 über den Schutz der Kulturpflanzen*) it is possible to make regulations governing the control of stored foodstuffs.

Germany (Fed. Rep.)

ORGANISATION. The general organisation of all measures for the protection of stored foodstuffs is the responsibility of the Federal Ministry of Agriculture and Forests, which provides funds to the Plant Protection Services of the various Länder for this purpose.

The German Plant Protection Service acts in an advisory capacity to those in charge of storehouses, mills and agricultural establishments on all questions relative to stored foodstuffs. This Service also organises propaganda campaigns and carries out large-scale disinfections. This work has been intensified under the 1952 European Recovery Programme. Special officers paid out of federal funds have been appointed to make known in all the Länder the methods of protection of stored household foodstuffs.

There is no general and regular inspection of all stocks (silos, storehouses, mills, granaries and farms). Periodic information is, however, obtained, covering as many stores as possible, in order to draw up statistics and with a view to the future organisation of control measures. Grain stores belonging to the Federal Government are regularly inspected by the service responsible for the importation and storage of grain and animal feeding stuffs. These inspectors are not scientific research workers, but men with practical experience — often grain merchants. Specialists are consulted in any case of serious infestation and control measures applied. The stored foodstuffs research services of the Federal Institute, which was destroyed during the war, are beginning to operate again.

The Plant Protection Service at Bremen inspects imported cereals in order to prevent the introduction of pests and their spread within the country. Cargoes are disinfected immediately on landing.

The Ministry of Agriculture, the Federal Institute of Agricultural Biology, and the Plant Protection Services distribute much printed matter relative to the protection of stored foodstuffs.

LEGISLATION. There is at present no special legislation for control measures, but the Plant Protection Law of August 1949 makes it possible for orders to be issued, and such an order under Section 3 of the Law is in fact in preparation. An order relative to inland mills would be valuable to ensure that all mills refuse to accept infested cereals from the farmers.

Denmark

LEGISLATION. Free advice is available to all. All stores held by the Government or commercially are inspected, and directions as to control of pests or suggestions as to improvements of storage are promptly accepted by those responsible. There is no legislative provision for the control of stored foodstuffs.

Sweden

ORGANISATION. No systematic action against pests of stored foods, such as cereals, is taken at ports of entry.

All mills and similar establishments are fumigated at least once a year to destroy insect pests such as *Ephestia kühniella* and rodents. Hydrocyanic acid and, more recently, methyl bromide, are the main fumigants employed.

In warehouses, fumigation of stored wheat is rare. Infested stores are generally treated by heat (warm air only or warm air under vacuum) by means of various drying devices. The same devices are used in the cold season for treatment by cold air; methods of this kind have proved 100% effective against many common pests of imported cereals. Chemical methods are also applied; in recent years pyrethrum-based products have been used increasingly.

Investigations of insect pests of stored foodstuffs, such as grain and milling products, are carried on at the Plant Protection Institute, Stockholm. The practical work is of an advisory nature. There is no legislative provision with regard to the control of pests on stored products.

Finland

ORGANISATION. Samples of all imported foodstuffs are examined at the port of entry; if found to be infested, they are referred to the Pest Investigation Division. No special control measures were required in 1952.

Inside the country, stores in warehouses, mills etc. are disinfected by commercial firms or by the owners themselves. Various methods of fumigation and spraying are used.

MEDITERRANEAN GROUP

Portugal

ORGANISATION. Protection of stored foodstuffs in Portugal is not the responsibility of the Plant Protection Service, but comes under various departments, such as the Maritime Sanitary Inspection Service in the ports of entry, and the General Inspectorate of Agricultural and Industrial Products in the interior of the country. The functions of the latter Service are only supervisory, the actual control work being carried out by other official and semi-official bodies. The most important is the National Federation of Wheat Growers, with 200,000 members and 550 storehouses throughout the country, handling about 500,000 tons of wheat a year, after retention by the farmers of the quantities needed for their own consumption and for seed. In each storehouse the temperature of the grain at different depths is registered twice a month, thus enabling the central service to be promptly notified of any case of infestation.

There is no comprehensive legislation governing the phytosanitary control of stored products. A decree of 16.4.29 deals with the control of rodents in ships.

METHODS. Carbon disulphide is used against weevils, either alone or combined with carbon tetrachloride to reduce the danger of fire. Sulphur dioxide is used against *Tinea* and *Sitotroga*. These methods of disinfection are supplemented by aeration and shovelling. Products with a DDT or BHC base are prohibited.

Carbon disulphide is used in different forms according to the degree of infestation : it is used in the form of gas for very heavy infestations, as a spray for medium infestations, and in liquid form for small localised infestations. Fumigation is maintained for two days and sprays for 3 days (with the lots under tarpaulin in the latter case). To reduce the temperature after treatment the grain is shovelled or moved mechanically.

Storehouses are first disinfected with products of a BHC or Cresol base and limewashed before being filled.

In general the problem of humidity does not arise in Portugal because grain shows only 14% moisture content. Maize is, however, an exception, and it is therefore stacked only up to 1.5 metres high, whilst wheat, barley and rye are stacked up to 2.5 and 3 metres.

All sacks used for transporting grain are disinfected with carbon disulphide in fumigation chambers belonging to the Wheat Growers' Federation.

The Cereals Commission for the Azores (responsible for the protection of stored foodstuffs in the islands) and the Rice Commission use similar control methods. Portuguese rice production already amounts to 141,000 tons, of which 5,000 are reserved for seed. The storage of rice (not husked) is easier than that of grain for bread.

Experiments with pyrethrum-piperonyl butoxide powders for the treatment of wheat are planned.

Italy

ORGANISATION. At the ports. — Goods unloaded into silos and stores belonging to agricultural co-operatives are disinfected. Other stores do not possess the necessary equipment.

The equipment used includes large metal containers which are hermetically sealed and fumigating chambers. The most commonly used gas-products are : carbon disulphide; mixtures of carbon disulphide-tetrachloride and dichloroethane; chlorinated insecticides with DDT and BHC base; chloroethane; insecticides with a dichloroethane base.

In the interior. — Privately owned stores are disinfected. The most commonly used gas products are : carbon disulphide; products of DDT and BHC base; Bentonite BB12; Gammexane dust and fumigant; dichloroethane fumigant.

Yugoslavia

LEGISLATION. The existing plant protection legislation makes no special provision for insects and other pests of stored foodstuffs. There is legal provision for the inspection of storehouses, but this does not prescribe control measures against pests. The Plant Protection Services therefore play an advisory role only.

Legislation is being prepared providing for the inspection of warehouses and control measures for insect pests of stored foodstuffs.

Greece

ORGANISATION. The problem of the protection of stored products in Greece is almost entirely limited to cereals, especially wheat, and to a lesser extent rice. The Phytopathological Service of the Ministry of Agriculture, in agreement with the Ministry of Supply, has taken the following steps :

1. It is recommended that all imported cereals should be disinfected before shipment.
2. The stores where imported cereals will be placed must be cleaned and disinfected.
3. In Piraeus and other parts of the country where cereals are stored, special commissions have been set up, including an agricultural engineer, a chemist, and a representative of the Ministry of Supply, their task being to find suitable stores and ensure that they are cleaned and disinfected, and to watch the condition of the grain and have it disinfected if it is dangerously attacked by insects.
4. The method of disinfection used is a mixture of three parts ethylene dichloride and one part carbon tetrachloride at 600 grams per cubic meter, for at least 48 hours.
5. If stores are found to be unsuitable for disinfecting the grain stored there, its immediate release for consumption is recommended.
6. Each province has been provided with sufficient quantities of ethylene dichloride and carbon tetrachloride for the disinfection of about 160,000 tons of cereals.

Algeria

LEGISLATION. There is no special service dealing with the control of stored food pests. In regard to cereals, the Algerian section of the *Office national interprofessionnel des céréales* arranges for control in silos and stores, and there are special arrangements for fumigation in silos. Before and during the war, the Plant Protection Service controlled foodstuffs stored in Algeria when they were held for long periods. Cereals are, however, no longer being stored for any length of time — hence the problem is not the same. Difficulties may arise in the future, and in this case there should be the same control as formerly.

For lentils (which are very important in Algeria), dried peas and beans, control is practised in the centres of production, usually by fumigation with methyl bromide. Prior to export they are also fumigated and there are special chambers for this purpose.

Effort is being made to ensure that figs and dates should be treated at the time of picking. The greater part of this crop is exported, and vacuum fumigation treatment is given before export.

Within the country big losses occur on goods for home consumption, which receive no treatment.

EQUIPMENT AND METHODS. There are nine vacuum fumigation stations controlled by the Plant Protection Service in the ports and the southern districts. The products used are hydrocyanic acid, methyl bromide and ethylene oxide. In the areas of production and storage, several centres for treatment under atmospheric pressure are used for treating figs, dates, dried legumes and seed potatoes. In addition, the chain of silos and warehouses reserved for cereals, with a capacity of 10 million quintals (4 million quintals in silos and 6 million in warehouses) is equipped with several plants for treatment.

REMARKS

Certainly there is room for improvement in the provision made in Algeria for the protection of stored foodstuffs. The warm and not too damp climate favours the quick development of insect and fungus pests, which thus present a greater danger than in the majority of European countries. A desirable improvement, and one which would result in rapid progress, would be to create a special service to deal with the protection of stored foodstuffs. This could be a section of the existing Plant Protection Service, enlarged for the purpose.

At present the Plant Protection Service is disinfecting some foodstuffs (figs, dates, legumes) before export, but this is definitely insufficient to prevent losses during storage and to satisfy the requirements of all foreign markets. For example, several countries, including the United States, rightly refuse to accept Algerian dates and figs, since they are treated only after they have become infested, and therefore contain dead insects.

It is very difficult to estimate losses, as they vary from period to period and from year to year. There were very big losses during the war when emergency stocks were held. Out of an annual crop of 12 to 14 million quintals of cereals, a loss of some 2-3 % may sometimes occur. The main worry is with lentils and pulses in general. Lentils are attacked by bruchids in the field, where there is at present no means of control. In regard to dates and figs, the loss is one of price ; if treatment in the field were possible the fruit would be healthy and would fetch higher prices.

Tunisia

ORGANISATION. The agricultural co-operatives, not the Ministry of Agriculture, are responsible for control measures.

They are vitally concerned with the destruction of insects of cereals (*Calandra*, *Sitotroga*, *Tribolium*).

Carbon tetrachloride is the most common product used, either by pouring pailsful on the stacks without any precise dosage, or by passing the tetrachloride through the grain by means of a tank containing 400 kgs. insecticide for each 20,000 quintals of grain. A closed circuit is formed by ventilation and slight heating. The first treatment is carried out in September-October, and is repeated 3 months later if necessary.

Methyl bromide is used only at Bizerta.

Malta

The Department of Agriculture has never been called upon to deal with pests of stored foods. Fumigation with carbon disulphide or hydrocyanic acid is occasionally carried out.

Israel

ORGANISATION. The following control measures against stored food pests are practised in the agricultural settlements in Israel and are included in the extension service of the Division of Plant Protection :

Preventive measures :

— Residual spraying or dusting of the empty stores and granaries with DDT preparations before introducing foodstuffs or grain.

— External dusting of bags, when filled with grain to be stored, while piling up the bags.

— Mixing of seeds with 5 % DDT dust at the rate of 1/1000 by weight.

Direct control measures :

— Fumigation with ethylene dibromide. Fumigation methods depend on type of store. Dosage : 70-100 gr/m^3.

Experience has shown that in some instances, after fumigation of sorghum (millet) with ethylene-dibromide the laying rate of hens, fed with grain, decreased. Further experiments are being made, but preliminary results have shown that special precautions need to be taken in the use of tested doses of poison (even in gaseous form) while fumigating grain intended for consumption by men and livestock.

PESTS OF STORED FOODS

Some Common Synonyms

The Latin names used in this publication appear in **bold type.**

1. **Acanthoscelides obtectus** Say. = *Bruchidius obtectus* Say.
2. *Blattella germanica* L. — See 16.
3. *Borkhausenia pseudospretella* Stt. — See 13.
4. *Bruchidius maculatus* — See 6.
5. *Bruchidius obtectus* Say. — See 1.
6. **Callosobruchus maculatus** Fab. = *C. quadrimaculatus* F. = *Bruchidius maculatus.*
7. *Callosobruchus quadrimaculatus* Fab. — See 6.
8. **Ephestia kühniella** Zell. = *Ephestia sericarium.*
9. *Ephestia sericarium* — See 8.
10. *Glycyphagus cadaverum* Schr. — See 11.
11. **Glycyphagus destructor** Schr. = *Glycyphagus cadaverum* Schr.
12. **Gnorimoschema operculella** Zell. = *Phthorimaea operculella* Zell.
13. **Hofmannophila pseudospretella** Stt. = *Borkhausenia pseudospretella* Stt.
14. **Laemophloeus ferrugineus** Steph. = *Laemophloeus testaceus* Payk.
15. *Laemophloeus testaceus* Payk. — See 14.
16. **Phyllodromia germanica** L. = *Blattella germanica* L.
17. *Phthorimaea operculella* Zell. — See 12.
18. *Sitodrepa panicea* L. — See 19.
19. **Stegobium paniceum** L. = *Sitodrepa panicea* L.
20. **Tenebroides mauritanicus** L. = *Tragosita mauritanica.*
21. *Tragosita mauritanica* — See 20.
22. **Tribolium castaneum** Herbst. = *Tribolium ferrugineum* Auct. = *Tribolium navale* Auct.
23. *Tribolium ferrugineum* Auct. — See 22.
24. *Tribolium navale* Auct. — See 22.

B. *Please supply a list of the principal stored food pests in your country, together with particulars of (a) relative importance, (b) incidence, (c) commodities infested, (d) storage conditions.*

For Mediterranean countries only : Does Calandra oryzæ *and/or* Sitotroga cerealella *infest grain* in the field *in your country ?*

SPECIES (*)	IMPORTANCE AND INCIDENCE	COMMODITIES INFESTED	STORAGE CONDITIONS

NORTHERN GROUP

Ireland

Calandra granaria *L.*	*Mainly in imported grain.*	—	—
Acarina	—	*Manufactured cereal products (e. g. flour, pollard).*	—

United Kingdom

ESTABLISHED PESTS (Pests established in England and Wales and capable of maintaining themselves without reinforcement from abroad, although these pests are liable to be constantly introduced in infested imports).

I. *Established pests of major importance*

Ephestia elutella *Hübn.*	*Common in food and tobacco warehouses, especially in the South, although outbreaks have occurred in Scotland; also occurs in food factories and shops. Attacks cereals and cereal products, spices, dried fruit, oilseeds, oilcakes, compound feeding stuffs, nuts, leaf and manufactured tobacco, cocoa beans and confectionery. Usually one complete generation a year ; development in the food takes 6-8 weeks (July-September). Uncommon on imports, being mainly confined to foods from the Mediterranean and Australia. Very occasionally from Canada.*
Ptinus tectus *Boiel.*	*Common over the whole country, perhaps more so in the North. Attacks all kinds of food but tends to avoid whole grain in favour of ground materials. Serious pest of flour. Readily attacks food of animal origin, e. g. fish meal and any food of high vitamin B content, e. g. dried yeast. Damages sacks by cutting fibres to make exit holes. 2-3 generations a year. Breeds best under damp undisturbed conditions. Uncommon on imports. Has been found occasionally in goods from Australia.*
Tyroglyphus farinae *L.*	*Common over the whole country, especially in the damper areas (e. g. North-West). A major pest of stored wheat, but will attack all kinds of cereals and cereal products and animal feeding stuffs. Breeds continuously throughout the year. Commonly introduced, especially on Canadian wheat. Liable to be brought from fields on newly harvested wheat.*
Calandra granaria *L.*	*Widely distributed in port and inland warehouses, silos, maltings and mills and also in farm granaries. Attacks whole grain, especially wheat and barley. In company with the following two species, causes appreciable losses to farm-stored grain each year. Measures taken against it in large stores have been generally effective. Commonly introduced on grain (especially wheat and barley) from Argentine and Australia.*
Oryzaephilus surinamensis *L.*	*Similar distribution to* Calandra granaria. *Has caused damage to wheat by attacking germ and inducing heating, acting as a primary pest in the absence of other pests. Also attacks other whole grain, including rice, cereal products, animal feeding stuffs, dried fruit and nuts. Breeds rapidly in grain once it has induced heating, but this may occupy long latent period. Commonly introduced on imports, from all parts of the world, being more common on starchy foods than* Oryzaephilus mercator *Fauv., which tends to occur more on oilseeds.*

(*) A number of taxonomic synonyms are listed on the opposite page.

SPECIES	IMPORTANCE AND INCIDENCE	COMMODITIES INFESTED	STORAGE CONDITIONS

United Kingdom (Cont.)

Laemophloeus ferrugineus *Steph.*

Established in most port and inland warehouses, but not so widespread on farms as the preceding two species. Damages grain by attacking germ and causing rapid heating, especially in grain of moisture content of 14% or upwards. Capable of attacking whole wheat and inducing heating in the absence of other pests. One of the few insects found at all commonly on Canadian wheat on arrival, especially that shipped from Vancouver. Found in cereals, cereal products, oilseeds, oilcake and rice from all parts of the world.

Trogoderma granarium *Everts.*

A major pest of malt in maltings where artificial heating in winter enables it to survive. Established in a large number of maltings all over the country, including distilleries in the Highlands of Scotland. Is regularly introduced in barley from N. Africa, Cyprus, Irak and Persia, in pulses or grain from E. Africa, in grain from the Sudan and in groundnuts from W. Africa.

Ephestia kühniella *Zell.*

Occurs throughout the United Kingdom in flour provender and malt mills, flour warehouses, flour packers and bakeries. Principally a pest in the machinery of flour mills, necessitating constant cleaning and annual fumigation of flour mills. Introduced in Australian flour, wheat germ, and in wheat offals from the Mediterranean and Argentina.

2. *Established pests of minor importance*

Plodia interpunctella *Hübn.*

Especially a pest of maize and dried fruit. Established in a few warehouses. Introduced in dried fruit, oilseeds and maize. Replaces Ephestia elutella *locally, especially in the South West.*

Aphomia gularis *Zell.*

A serious pest of nuts. Established in a few warehouses in London and in the North of England, especially those connected with seed dressing and nut cleaning.

Endrosis sarcitrella *L.*

Widespread in all parts of the U. K. as a warehouse and domestic pest. Requires conditions of high humidity and is therefore only seldom serious. Particularly a pest of pulses.

Stegobium paniceum *L.*

Generally distributed, especially in heated premises and in shops. One of the most common larder pests.

Carpoglyphus lactis *L.*

Generally distributed : a pest of dried fruit and preserves. Introduced in dried fruit from Turkey and other countries.

Glycyphagus destructor *Schr.*

Occurs frequently in stored wheat, where it apparently feeds on dust and broken grain. Widespread. Introduced in Canadian wheat and other grain.

INTRODUCED PESTS

(Pests which are not established, but which can continue to damage food in which they are introduced or other commodities, by cross-infestation).

Calandra oryzae *L.*

Occurs in most port warehouses and inland where it is carried on imported grain. Occurs generally in grain from the tropics and subtropics, including maize from U. S. A. and grain from Australia. May also occur in pulses from E. Africa.

Rhizopertha dominica *Fab.*

Occurs in grain, especially wheat and barley from tropics and subtropics, including Australia. Tends to occur most frequently in grain of low moisture content, e. g. Mediterranean, Irak and Persian barleys and Australian wheat. Has survived English winters deep in large stacks and bulks of grain and caused heating and damage in the subsequent summer.

Tribolium castaneum *Herbst.*

Very common in imported grain and other food, especially oilseeds and rice bran. Continues to breed during summer. Mainly confined to port warehouses, port and inland flour and provender mills and oilseed crushing mills.

Ephestia cautella *Walk.*

Although not so important as E. elutella, *this species can sometimes survive winter conditions. Tends to be confined to port warehouses, chocolate factories and oilseed crushing mills. Occurs on foodstuffs from all except temperate regions. Foods infested include oilseeds and oilcake, wheat (Australia), maize (Burma, Argentina, East Africa), rice, cereal products, nuts.*

BRUCHIDÆ

Acanthoscelides obtectus *Say.*
Spermophagus subfasciatus *Boh.*
Callosobruchus chinensis *L.*
C. maculatus *F., etc.*

Cause severe damage to beans before arrival in this country and for that reason such beans are not acceptable to canners, even if the insects are killed. The most infested beans are from E. Africa.

SPECIES	IMPORTANCE AND INCIDENCE	COMMODITIES INFESTED	STORAGE CONDITIONS
France			
Calandra granaria *L.*	*Causes annual losses of 0.2-0.4% of wheat; higher losses on maize. Damage to coarse grains negligible ; variable on by-products.*	*Wheat, coarse grains, maize, flour products, flour.*	*Normally cereals are sent within varying periods after the harvest direct to a central organisation, which distributes them to the mills or for sale, keeping part back for seed. The farmers keep cereals for consumption, usually loose, and in stores not equipped for the purpose. Flour pastes are stocked in the factories or in retail shops.*
Calandra oryzae *L.* **Tenebroides** **Oryzaephilus** **Laemophloeus** **Tribolium** *spp.* **Tenebrio** **Anobium** **Ephestia** **Tinea granella** *L.*	*Widespread in mills. Economic importance varies ; fairly high in domestic stocks and goods stored for a long period.*	—	
Sitotroga cerealella *Ol.*	*Causes much damage to maize in store and to old stocks of wheat.*	—	
Belgium			
	Coleoptera		
CURCULIONIDÆ			
Calandra granaria *L.*	*Very common. Losses serious.*	*All stored cereals, home-produced and imported.*	
Calandra oryzae *L.*	*Very common. Losses serious, often in association with secondary parasites such as* Tribolium *and* Rhizopertha.	*All cereals — particularly imported — rice, maize, sorghum and their products.*	*Granaries, silos, barges and warehouses, in bulk and in sacks.*
Calandra zea mais *Motsch.*	*Very common. Losses serious.*	*Imported cereals, especially maize.*	
BRUCHIDÆ			
Acanthoscelides obtectus *Say.*	*Very common. Losses serious.*	*Various legumes, particularly* Phaseolus. *(Also attacks the growing crop).*	*Usually in sacks in granaries.*
Callosobruchus maculatus *F.*	*Very common and losses serious in the years after the war. Now much less common.*	Voanzia subterranea, *chick peas, cowpeas and other legumes.*	*Silos, barges, warehouses.*
Bruchus rufimanus *Boh.*	*Very common and harmful.*	*Home-produced and imported field beans.*	*Silos, warehouses, barges.*
Bruchus pisorum *L.*		*Home-grown peas.*	*Granaries.*
TENEBRIONIDÆ	(The **Tenebrionidæ** and **Cucujidæ** are secondary pests of grain. They do not attack healthy grain, but can cause much damage to grain previously attacked by primary pests. They are always dangerous in milled and manufactured products because of their power to reproduce rapidly).		
Tenebrio molitor *L.*	*Very common, especially in damp and dark places.*	*Flour and other milled cereal products.*	*Warehouses, mills.*
Tenebrio obscurus *F.*	*Very rare.*	—	—
Tribolium confusum *Duv.* **T. castaneum** *Herbst.*	*Very common.*	*Cereals attacked by weevils, flour and other cereal products ; oilcakes ; meat meal, and various offals.*	*Warehouses, stores, barges.*

SPECIES	IMPORTANCE AND INCIDENCE	COMMODITIES INFESTED	STORAGE CONDITIONS
Belgium (Cont.)			
Gnathocerus cornutus *F.*	*Very common.*	*Cereals attacked by weevils, flour and other cereal products, oilcakes ; meat meal and various offals.*	*Warehouses, stores, and barges.*
Latheticus oryzae *Water.*	*Common.*		
Caenocorse depressus *F.*			
C. ratzeburgi *Wissm.*			
CUCUJIDÆ			
Oryzaephilus surinamensis *L.*	*Very common.*	*All grains attacked by primary pests : weevils,* Rhizopertha, Tinea granella, *etc.*	
O. mercator *Fauv.*	*Common.*	*Cereal products and offals, oilseeds.*	
Ahasverus advena *Walt.*			
Laemophloeus *spp.*	*Very common.*	*Linseed cake, cotton cake, palm kernel cake, etc.*	
PTINIDÆ	(The **Ptinidae**, especially the first two species, have been found to a disturbing extent in rice products stored in jute sacks).		
Ptinus fur *L.*	*Very common.*	*Various stored foods, cereals, flour and other stored products, malt germs, meat meal, cassava flour, linseed cake, palm kernel cake, rice protein, compound cattle cakes.*	*Mainly in buildings with thatched roofs.*
P. tectus *Boield.*			
P. pusillus *Sturm.*			
P. brunneus *Duft.*	*Common.*		
P. latro *E.*			
P. bicinctus *Sturm.*			
Niptus hololeucus *Fald.*			
Gibbium psylloides *Czenp.*	*Very common.*		
ANOBIIDÆ			
Stegobium paniceum *L.*	*Very common, polyphagous and extremely prolific.*	*All cereal derivatives and manufactured products ; oilcakes, spices, etc.*	—
Lasioderma serricorne *F.*			
Ernobius mollis *L.*	*Very common. Found in the beams and floors of warehouses.*	*Timber.*	—
Ptilinus pectinicorni *L.*			
Anobium striatum *Ol.*			
Xestobium rufovillosum *Deg.*			
BOSTRICHIDÆ			
Rhizopertha dominica *F.*	*Very common. An important primary pest.*	*Imported cereals.*	*Barges, silos and warehouses.*

SPECIES	IMPORTANCE AND INCIDENCE	COMMODITIES INFESTED	STORAGE CONDITIONS
Belgium (Cont.)			
DERMESTIDÆ	(The **Dermestidæ** do little damage to cereals and cereal products. They are chiefly harmful through fouling the goods. The larvae cause damage to the silk sieves in mills).		
Dermestes lardarius *L.* **D. frischi** *Kugel.* **Attagenus piceus** *Ol.* **A. pellio** *L.* **Anthrenus** *spp.*	*Very common.*	*Hides and skins, meat meal, bone meal, fish meal, cotton cake, groundnut flour, various offals.*	*Stores and warehouses.*
LATHRIDIIDÆ *CRYPTOPHAGIDÆ* *MYCETOPHAGIDÆ*	(All these pests are common in cereals and various other vegetable products which have begun to deteriorate and have developed high humidity. They do not attack foodstuffs directly, but live in the moulds. Damage nil or negligible.)		
OSTOMATIDÆ			
Tenebroides mauritanicus *L.*	*Very common.*	*Cereals and cereal products, cassava, soya beans, groundnuts, oil cakes, etc.*	*Stores and warehouses, railway waggons, ships etc.*
	(This is an important parasite of the pests of stored products, but equally harmful to the products themselves. It penetrates wood easily and hides in the beams of warehouses, where it can remain a long time).		
	Orthoptera		
Phyllodromia germanica *L.* **Blatta orientalis** *L.* **Gryllus domesticus** *L.*	*Very common. Especially obundant in bakehouses, hotel kitchens, factories, etc. More of a nuisance than harmful.*	*Flour.*	—
	Corrodentia		
Troctes divinatoria *Müll.*	*Very common. Not very harmful.*	*Various offals.*	—
	Thysanura		
Lepisma saccharina *L.*	*Very common, especially in dark places. Not very harmful.*	*Flour, sugar, etc.*	—
	Microlepidoptera		
PYRALIDIDÆ			
Ephestia kühniella *Zell.*	*Very common. Extremely harmful in the majority of mills, causing stoppages of pipes and machinery, fouling, and loss of flour.*	*Flour and cereals, and all manufactured cereal products.*	*Flour bins in mills, flour in sacks in stores, grain both loose and in sacks.*
Pyralis farinalis *L.*	*Now rare, though still found in some bakehouse stores.*	*Cereals, flour and other milled products.*	*Flour in sacks.*
Plodia interpunctella *Hbn.*	*Very common. Has been found in great abundance in a vegetable drying factory and on imported wheat.*	*Grain, flour for bread-making, milk powder, various seeds, soya, dried fruit, etc.*	—
Ephestia elutella *Hbn.*	*Very common. Sometimes found in abundance in stores of cocoa beans, up to 20% of those in Belgium sometimes being infested. Very harmful in warehouses and chocolate factories. Also found in haylofts.*	*Cocoa beans and their products ; also in cereals, nuts, dried fruit, tobacco, and in hay on the farm.*	*Cocoa beans are usually stored in sacks in large warehouses. This also applies to the nuts used in chocolate manufacture.*

SPECIES	IMPORTANCE AND INCIDENCE	COMMODITIES INFESTED	STORAGE CONDITIONS
Belgium (Cont.)			
TINEIDÆ			
Tinea granella *L.*	*Very common and harmful in farm granaries. Stock refuse grain that is heavily infested.*	*Wheat, more often rye, rarely barley or oats.*	*Rye stored in bulk in the granaries.*
GELECHIIDÆ			
Sitotroga cerealella *Oliv.*	*Imported maize is often heavily infested.*	*Wheat, spelt, barley, maize.*	*Unthreshed grain in stack. Maize cobs.*
Endrosis lactella *Schiff.*	*Common. Has often been found lightly infesting elevators in mills.*	*Flour, bran, linseed cake.*	*Mills.*
Depressaria purpurea *How.*	*Very rare.*	*Wheat screenings.*	—
Hofmannophila pseudospretella *Stt.* **Borkhausenia minutella** *L.*	*Common. Often found in small numbers in milling machinery.*	*Grain, flour, bran.*	*Mills.*
	Acarina		
TYROGLYPHIDÆ			
Tyroglyphus farinae *L.*	*Very common and harmful. Attacks first the grain, then the kernel of cereals. Infested foodstuffs rapidly become unfit for consumption.*	*All cereals in store, their milled products and manufactured products.*	*Silos, warehouses, barges, stores, in sacks or in bulk.*
Aleuroglyphus ovatus *Troup.*	*Relatively rare.*	*Foodstuffs rich in fats and albumen and relatively damp.*	
Caloglyphus berlesei *Mich.*	*Relatively rare. Develops only under damp and putrefying conditions.*	*Cereals, groundnuts, linseed, and various decomposing products.*	
RHIZOGLYPHIDÆ			
Rhizoglyphus echinopus *F. & R.*	*Very common in tulip and hyacinth and other flower bulbs. Needs special conditions of humidity.*	*Germinating cereals.*	
TYROPHAGIDÆ			
Tyrophagus castellani *Hirst.*	*Very common and very polyphagous. Needs special conditions of humidity. Very prolific in all decomposing foodstuffs.*	*All kinds of foodstuffs when they are sufficiently damp.*	*Wheat heating in silos or on barges. Packaged or loose material in warehouses.*
Tyrolichus casei *Ouds.*	*Very common. Polyphagous.*	*Various food products, especially cheese.*	—
Tyrophagus dimidiatus infestans *Berlese.*	*Common. Polyphagous.*	*Various food products ; decomposing products.*	—
Tyroborus linii *Ouds.*	*Rare. Almost exclusively in old stocks of linseed, and usually in association with* Tyroglyphus farinæ *L.*	*Linseed.*	—
CARPOGLYPHIDÆ			
Carpoglyphus lactis *L.*	*Common.*	*Sweetstuffs, syrups, jam, honey, dried fruit (dates, figs, etc.).*	*Stores and warehouses of wholesalers and retailers.*

SPECIES	IMPORTANCE AND INCIDENCE	COMMODITIES INFESTED	STORAGE CONDITIONS
Belgium (Cont,)			
GLYCYPHAGIDÆ			
Glycyphagus domesticus *Deg.*	*Very common, often invading houses and making them uninhabitable.*	*Hay, vegetable horse-hair, arm chair stuffing, grains, etc.*	*Buildings. Granaries.*
Lepidoglyphus destructor *Schrank.*	*Very common.*	*Cereal grains and hay.*	*Granaries.*
Glycyphagus ornatus *Kramer.*	*Rare.*	*Husks of cereals. Linseed flour.*	—
Chortoglyphus arcuatus *Troup.*	*Common.*	*Clover seed, cereals and their milled products.*	*Warehouses of cattle food manufacturers.*
Gohiera fusca *Ouds.*	*Very common. Often associated with* Tyroglyphus farinae *L.*	*Milling by-products, especially bran.*	*Mills.*
Suidasia nestbitti *Hughes.*	*Rare. When abundant it gives the grain a distinctive smell.*	*Grains.*	*Silos, barges, warehouses.*
Mealia maynei *Coorem.*	*Rare. A new species.*	*Cotton cake.*	*Barges, warehouses.*
Megninietta molaris *Cooreman.*	*Rare. A new species. Was found in abundance in certain pipes of a mill.*	*Milling by-products.*	—
Netherlands (*)			
		Coleoptera	
Calandra granaria *L.*	*Great. — Common.*	*Cereals.*	
Calandra oryzae *L.*	*Small. — Common.*		
Rhizopertha dominica *F.*	*Great. — Common.*	*Cereals, especially in African barley.*	
Oryzaephilus surinamensis *L.*	*Small. — Common.*	*Cereals, linseed cake, etc.*	
Laemophloeus ferrugineus *Steph.*			
Laemophloeus minutus *Ol.*	*Occasionally.*	*Cereals, sunflower seed.*	
Tribolium confusum *D.*	*Common.*	*Flour and vegetable products.*	
Tribolium castaneum *Herbst.*			
Tenebrio molitor *L.*	*Occasionally.*	*In warehouses.*	*Cf. p. 20.*
Tenebroides mauritanicus *L.*		*Cocoanut cake.*	
Gnathocerus cornutus *F.*	*Small. — Seldom.*	*Flour.*	
Latheticus oryzae *Wat.*		*African barley.*	
Lasioderma serricorne *F.*	*Great. — Common.*	*Tobacco, cocoanut cake.*	
Stegobium paniceum *L.*		*Vegetable products.*	
Niptus hololeucus *Fald.*	*Small. — Seldom.*	*In warehouses.*	
Ptinus fur *L.*	*Small. — Common.*	*Fish meal.*	
Ptinus tectus *Boiel.*			
Ahasverus advena *Wal.*	*Small. — Seldom.*	*Cocoanut cake.*	
Alphitobius diaperinus *Panz.*		*Millet seed.*	

(*) In the second column, the first word gives the relative importance of the pest, the second its incidence.

SPECIES	IMPORTANCE AND INCIDENCE	COMMODITIES INFESTED	STORAGE CONDITIONS
Netherlands (Cont.)			
Dermestes lardarius *L.*	*Small. — Seldom.*	*In warehouses and farms.*	
Dermestes maculatus *Deg.*	*Great. — Common.*	*Hides and animal products.*	
Dermestes ater *Deg.*			
Attagenus pellio *L.*	*Small. — Common.*	*Hides and in warehouses.*	
Necrobia rufipes *Deg.*	*Small. — Common.*	*Copra, cocoanut cake.*	
Necrobia pilifera			
Necrobia ruficollis *F.*	*Small. — Seldom.*		
Acanthoscelides obtectus *Say.*	*Great. — Common.*	*Beans.*	
Callosobruchus maculatus *F.*	*Small. — Seldom.*	*Peas (imported).*	
Bruchus pisorum *L.*			
Bruchus rufimanus *Boh.*	*Great. — Common.*	*Broad beans.*	
Spermophagus subfasciatus *Boh.*	*Small. — Seldom.*	*Angola beans.*	
Araecerus fasciculatus *Deg.*	*Small. — Occasionally.*	*Coffee.*	*Cf. p. 20.*
	Lepidoptera		
Sitotroga cerealella *Ol.*		*Cereals.*	
Ephestia kühniella *Z.*		*Flour, in mills.*	
Ephestia elutella *Hbn.*	*Great. — Common.*		
Plodia interpunctella *Hbn.*		*Vegetable products.*	
Tinea granella *L.*	*Small. — Common.*	*Seeds and grain.*	
Tinea pallescentella *St.*	*Small. — Seldom.*	*Fish meal.*	
Tineola bisselliella *Humm.*	*Small. — Common.*	*Fish and meat meal.*	
	Acarina		
Glycyphagus destructor *Schrk.*	*Small. — Occasionally.*	*In meat meal.*	
Tyrophagus castellani *Hirst.*			
Tyroglyphus farinae *L.*	*Great. — Common.*	*Cereals. Flour.*	
Saar			
Calandra granaria *L.*	*Most common of all.*	*Wheat, rye, oats, barley, maize ; sometimes in decorticated rice and flour products.*	*Cf. p. 21.*
Ephestia kühniella *Z.*	*Occasional outbreaks in mills.*	*Grain and grain products (imported packed flour and semolina).*	—
Acanthoscelides obtectus *Say.*	*Common in imported legumes.*	*Legumes.*	—
Bruchus atomarius *L.*			
B. lentis *Froel.*			
B. pisorum *L.*			

(With the exception of **A. obtectus**, these bruchids cannot reproduce in stores and therefore do not threaten stored products directly).

SPECIES	IMPORTANCE AND INCIDENCE	COMMODITIES INFESTED	STORAGE CONDITIONS
Switzerland			
In Switzerland there is no station specially concerned with stored product insects, and no systematic study has been made of their incidence or their importance in relation to the stored products and the conditions of storage. The main insects concerned are however those which are known in the other countries of Europe.			
Austria			
Calandra granaria *L.*	*Widespread throughout country.*	*Especially on imported cereals in silos, storehouses, stores on floors ; also on home-produced cereals.*	—
Glycyphagus domesticus *Deg.* **G. destructor** *Schr.* **Tyroglyphus farinae** *L.*	*Infestation by these mites is increasing, especially in imported cereals.*		—
Ephestia kühniella *Z.*	*Occurs in flour-mills and storehouses.*	—	—
Germany (Fed. Rep.)			
Calandra granaria *L.*	*By far the most important and widespread of the cereal pests. Estimated to cause losses of 2 — 2 1/2% of cereals annually. 30% of farm stores are infested.*	*All cereals.*	*Farm stores, mills, granaries, silos. Seldom in sacks.*
Ephestia kühniella *Zell.*	*The most important and widespread pest in mills and in the food manufacturing industries.*	*Cereal products. Cocoa and its derivatives.*	*Chiefly sacks and packages.*
Tyroglyphus farinae *L.*	*Widespread in cereals and flour. In 1952, infestation was particularly severe in damp grain.*	*Cereals and flour.*	*Cereals : granaries and silos. — Flour : sacks.*
Tribolium *spp.*	*Widespread in mills and cereal warehouses.*	*Cereals and cereal products.*	
Oryzaephilus surinamensis *L.* **Laemophloeus** *spp.*	*Widespread, especially in cereal warehouses. In recent years several large-scale infestations have occurred, causing considerable losses.*	*Cereals.*	*Granaries and silos.*
Tinea granella *L.*	*Widespread among cereals. Damage usually slight.*	*All cereals.*	*Mainly granaries.*
Calandra oryzae *L.*	*Not indigenous, but often introduced on imported cereals. Survives the winter only in warm districts or in cereals with high temperature. Serious damage.*		
Rhizopertha dominica *F.*	*Not indigenous, but recently often imported on cereals. Does not survive the winter. No important damage.*		*Granaries and silos.*
Trogoderma granarium *Ev.*	*Now imported only occasionally on cereals. No important damage.*	*Cereals, malt.*	
Sitotroga cerealella *Ol.*	*Sometimes introduced on imported cereals. Does not survive the winter. No important damage.*	*Cereals.*	
Tenebroides mauritanicus *L.*	*Widespread in warehouses and mills. Serious damage is rare.*	*Cereals and cereal products.*	
Tenebrio molitor *L.*	*Widespread, especially in mills. Serious damage is rare.*	*Flour and other cereal products.*	*Chiefly sacks.*
Stegobium paniceum *L.*	*Widespread. Sometimes causes serious damage.*	*Food products of all kinds.*	*Warehouses, food stores.*

SPECIES	IMPORTANCE AND INCIDENCE	COMMODITIES INFESTED	STORAGE CONDITIONS
Germany (Fed. Rep.) (Cont.)			
Hofmannophila pseudospretella *Stt.*			
Plodia interpunctella *Hb.*		*Many kinds of food products.*	*Granaries, sacks.*
Ephestia elutella *Hb.*			
Acanthoscelides obtectus *Say.*	*Very widespread. Important damage.*	*Legumes.*	*Floors and sacks.*
Dermestes lardarius *L.*		*Stored meat of all kinds.*	
Piophila casei *L.*		*Stored meat of all kinds. Cheese.*	*Storage and curing chambers.*
Blatta orientalis *L.*	*Widespread.*	*Food products of all kinds.*	*Food product factories. Storage chambers.*
Phyllodromia germanica *L.*			
Denmark			
Detailed particulars are published in the Annual Report of the *Statens Skadedyrlaboratorium* (Government Pest Infestation Laboratory), Springforbi.			
Sweden			
Ephestia kühniella *Z.*	*Common throughout country in flour mills ; frequent outbreaks in bakeries, warehouses, chocolate factories.*	*Wheat and wheat products, etc. Also hard rye bread (severe attacks) in store.*	—
Tinea infimella *H.-S.*	*Formerly a major, now a minor pest in farm granaries.*	*Rye, wheat, peas (stored for the summer).*	
	(Effective control with DDT and BHC).		*Large-scale storage of grain for long periods is made mainly in bulk on floors, sometimes in temporary storehouses such as rebuilt cow-houses, barns, etc.*
Calandra granaria *L.*	*Established in South.*	—	
Calandra oryzae *L.*	*Frequent in imported grain (many cases of severe damage during storage).*	*Imported grain.*	
Rhizopertha dominica *F.*	*Another major pest in imported grain.*		
Tribolium destructor *Uytt.*	*Now the principal household pest, established in most of the country.*	*Especially common in stores of groats and other oat products, but also in other flour products, in hard rye bread, almonds, raisins, etc.*	—
Laemophloeus ferrugineus *Steph.*	*Most common of the L. genus, frequently causes extensive damage (chiefly through high temperatures caused by its attacks). May now be an established pest.*	*Common in large stores of grain, especially wheat and rye. Also in bran and other foods.*	—
Tyroglyphus farinae *L.*			
Glycyphagus domesticus *Deg.*	*Common in various foodstuffs in farms and poultry houses. Stored grain also heavily infested in certain years.*	—	—
Tyroglyphus longior *Gerv.*			

SPECIES (*)	IMPORTANCE AND INCIDENCE	COMMODITIES INFESTED	STORAGE CONDITIONS

MEDITERRANEAN GROUP

France

See p. 29.

Italy

Sporadic attacks of grain *in the field* by *Sitotroga cerealella* have been reported; their importance is negligible. No similar attacks by *Calandra oryzae* are known to occur in Italy.

Portugal

Calandra oryzae *L.*	*Most common of all (often mistaken for C. granaria).*	*Cereals and cereal products.*	*See p. 23.*
Calandra granaria *L.*	*Also widespread.*		
Tinea granella *L.*	*Widespread.*		
Sitotroga cerealella *Ol.*	*Less common.*		
Ephestia kühniella *Z.*	*Also found in warehouses.*		
Ephestia elutella *Hbn.*			
Pyralis farinalis *L.*			
Tenebroides mauritanicus *L.*			
Laemophloeus ferrugineus *Steph.*			
Attagenus piceus *O.*			
Stegobium paniceum *L.*			
Tribolium castaneum *Herbst.*			
Tribolium confusum *Duv.*			
Tenebrio molitor *L.*			
Gnorimoschema operculella *Zell.*	*Causes heavy losses to potatoes in store (June to November).*	*Potatoes.*	

(This pest can easily be controlled by proper storing and light dusting with 2.5-5 % DDT (1 kg per ton).

No cases of infestation *in the field* by *Calandra* species have been observed. The behaviour of *Sitotroga cerealella* has not recently been studied, but it may be assumed that this insect can attack grain in the field, since it is a species intermediate between plant-eaters and grain-eaters. Also, ears of wheat infested with *Sitotroga* are found even before threshing.

(*) A list of taxonomic synonyms appears on p. 26.

SPECIES	IMPORTANCE AND INCIDENCE	COMMODITIES INFESTED	STORAGE CONDITIONS
Yugoslavia			
Calandra granaria *L.*	*Long established throughout the country. (Annual losses on maize estimated at 15-20% of total crop.)*	*All cereals, especially wheat, barley, rye. A major pest of maize.*	*Storage conditions are far from satisfactory, because generally speaking the foodstuffs are stored by the producers in granaries where disinfection is impossible. Commercial undertakings and provision factories are an exception, but whilst they possess premises well suited to the storage of foodstuffs, preventive measures are applied only in very few eases. Commercial undertakings for medicinal plants in the Voyvodina do possess disinfection chambers.*
Calandra oryzae *L.*	*Exists in association with* C. granaria *in grain stores, but less abundant.*	*Especially rice.*	
	(Introduced with imported rice some years ago. Not a serious danger at this time).		
Acanthoscelides obtectus *Say.*	*Established throughout country. Damage to beans estimated at over 10% of total crop (in some cases infests some four fifths of stock, which becomes unfit for human consumption).*	*Especially beans.*	
	(Introduced about 1934).	—	
Bruchus pisorum *L.*	*Entire country heavily infested ; practically all stores of peas attacked.*	*Peas.*	
Sitotroga cerealella *Ol.*	*Long established and also very widespread (Dalmatia especially).*	*All cereals.*	
	(Female lays on grain **in the field** ; pest thus introduced on grain into storehouses.)		
Ephestia kühniella *Zell.*	*Throughout country, especially in mills and granaries.*	*Bran, grain, dried fruit.*	
Ephestia elutella *Hbn.*	*Throughout country.*	*Dried fruit and vegetables, medicinal plants, stored tobacco.*	
Tinea granella *L.*	*Throughout country, but not abundant.*	*Cereals, legumes. (Observed on rye in Croatia).*	
Gnorimoschema operculella *Zell.*	*Increasingly heavy damage from year to year in Dalmatia, Istria, Croatia.*	*Stored potatoes.*	
	(First recorded in 1939.)		
Tenebroides mauritanicus *L.* **Stegobium paniceum** *L.* **Plodia interpunctella** *Hbn.* **Tribolium confusum** *Du.* **Tenebrio molitor** *L.*	*Also exist.*	*Flour, pastes, dried fruit, medicinal plants, etc.*	
Greece			
Plodia interpunctella *Hbn.* **Sitotroga cerealella** *Ol.* **Tinea granella** *L.* **Tribolium confusum** *Du.* **Calandra oryzae** *L.* **Calandra granaria** *L.* **Rhizopertha dominica** *F.* **Tenebroides mauritanicus** *L.* **Oryzaephilus surinamensis** *L.*	*Stores of imported grain.*	—	*Imported grain is stocked either in silos of mills or in stores, which for the most part are not suitable for the preservation of the products stored. Ships — which are very suitable for disinfection — are also used for storage.*

SPECIES	IMPORTANCE AND INCIDENCE	COMMODITIES INFESTED	STORAGE CONDITIONS

Algeria

Sitotroga cerealella is known to attack grain *in the field* in Algeria; no cases of such attacks by *Calandra oryzae* have been reported.

Cf. also p. 24.

Tunisia

Calandra oryzae has been known to infest grain *in the field* in Tunisia, but such attacks are extremely rare and are only of scientific interest. The economic importance of this pest is considered negligible.

Sitotroga cerealella attacks grain *in the field*. The pest lays its eggs in March and April between the sheaths while the grain is still at the milky stage.

Cf. also p. 24.

Israel

Calandra oryzae *L.*	*The most serious pest, found in every sample of infested grain.* Sometimes also found in the field.	*All cereals and some leguminous seeds;* Cicer arietinum.	—
	Since stored grain is free from **Calandra** during the first month after harvesting, it is assumed that the development of the pest is hindered by the low moisture content of the grain (9-10 %).		
Rhizopertha dominica *F.*	*Second in importance. Also a primary pest. Most dangerous in bulk grain storage.*	*Various cereals and also bran.*	—
	(This pest appears to fly easily, and may spread in this manner).		
Tribolium confusum *Duv.* **T. castaneum** *Herbst.*	*Always found associated together with* C. oryzea. *Secondary pests in grain, but major pests in all varieties of bran.*	—	—
Trogoderma granarium *Ev.*	*Very serious in the warmer regions (valleys). More abundant in store-rooms built partly or wholly of wood.*	*Various cereals.*	—
Sitotroga cerealella *Oliv.*	Attacks grain already in the field *(found in quantity on grain just harvested). Damage, however, is limited.*	*All grains, especially barley, wheat, maize.*	—
	(The pest's habitat is limited to the periphery of the stored grain. Furthermore, it cannot survive in dry grain).		
BRUCHIDÆ			
Pseudopachymerus chinensis *L.* **Callosobruchus maculatus** *F.*	*Serious pests of stored leguminous seeds. Attack the seeds in the field (as a rule) and in storage.*	*Many leguminous seeds.*	—

C. *Please supply particulars of instances where control of stored pests is difficult (e. g. fumigation of bulk grain stored on floors; methods of admixture of insecticides with grain; etc.)*

NORTHERN GROUP

Ireland

No special difficulties have been encountered in the control of pests. Where it is necessary to fumigate bulk grain stored on floors, the premises are sealed and the grain exposed to hydrogen cyanide gas for from 24 to 30 hours.

United Kingdom

The principal unsolved problems are those of practice rather than theory. The background of fundamental information provided by the Pest Infestation Laboratory (Department of Scientific and Industrial Research) is such that the toxicity of individual insecticides is known : it is getting the insecticide to the insect which provides the main difficulties. Research is proceeding on the following questions :

- Penetration of fumigants into bulk grain on floors at a stage when heating has started and there is caking.
- Control of *Trogoderma* in malt stored in brick and wood bins in warm situations.
- Control of *Oryzaephilus surinamensis* and *Laemophloeus* spp. in empty warehouses, especially when hidden deep in cracks.
- Control of mites in grain and flour owing to high resistance of their eggs and hypopial stages to fumigants.
- Control of deep seated infestation in ships' holds.
- Prevention of infestation and contamination of food.

The most important developing problem is the need to ensure that foodstuffs which pass to the consumer with little or no processing after import do not get infested in the countries of origin. Until recently the presence of small numbers of dead insects or mites has not been objected to, but food inspection authorities are more and more demanding insect and mite-free food. Fumigation on arrival in the U. K. is thus no longer satisfactory and there is need for adequate preventive and control measures in the countries of origin. Dried fruit is the main commodity concerned.

France

Foodstuffs are stored either in warehouses or in silos belonging to the cooperatives or to private individuals. These silos are rarely sufficiently airtight and only few installations have equipment for disinfection. The more defective the material conditions, and the longer the time of storage, the more difficult it is to control pests.

The admixture of insecticides with cereals is still only little practised, as also the dusting of sacks.

Fumigation of small stocks is not usually undertaken until infestation becomes heavy.

Belgium

No special difficulties have been met with. Fumigation is often impracticable on farms and other storage places, because of their lay-out and the condition of the partition walls. Admixture of grain with synthetic insecticides is not favoured for health reasons, since it is impossible to guarantee that the grain will be completely free of insecticide when milled, in which case produce such as eggs and butter might be affected.

Netherlands

In general control of storage pests in the Netherlands does not give much difficulty since warehouse conditions are good, and the silos at Rotterdam and Amsterdam have compartments for gassing.

Admixture of insecticides with grain is not allowed in the Netherlands in accordance with an act of 1924, amended in 1935.

Saar

No particular difficulties have been encountered in the control of pests of stored products.

Switzerland

The mixing of DDT with stored foodstuffs is forbidden by law. In exceptional cases, the chemists of the cantonal authorities may authorise the use of DDT (Geigy 33) for the treatment of wheat for bread-making on condition that it is specially washed before being milled.

The fumigation of bulked cereals on floors is not practised in Switzerland.

Austria

There are no difficulties in control in silos by fumigation (ethylene oxyde, hydrocyanic acid). On the other hand there are great difficulties in controlling the pests, especially *Calandra granaria*, in the farmers' stores. For this purpose DDT-dusts are used which are mixed with the grain; but the method is not popular in Austria and its use is strictly limited by regulations.

Germany (Fed. Rep.)

The fumigation of cereals stored in heaps in the granaries is carried out exclusively with products releasing phosphuretted hydrogen. Very good results are obtained. Difficulties arise, however, when the method is not authorised by law, as is the case with the majority of farm stores. In such cases there is doubt as to the method of fumigation which should be applied. Small quantities (up to about 15 quintals) of heavily infested grain are dusted with powders with a base of DDT or lindane, and recently with pyrethrum-piperonyl butoxide mixtures (100 g/100 kg). When the first two products are used the farmers are advised before using the grain to clean it thoroughly by winnowing, and if possible to mix it with an equal quantity of untreated grain. Large stocks, and especially Government stocks, are not treated by this method, which may be dangerous from the health standpoint. Treatment with pyrethrum-piperonyl butoxide was carried out for the first time in 1953, and not enough information has yet been collected as to its practical efficiency.

A really appropriate method for the fumigation of grain in ships has also not yet been discovered. The phosphuretted hydrogen method, suitable in principle, is impracticable because of the long duration (8 days) of the fumigation.

Steps taken jointly by the Ministry of the Interior (Federal Service of Public Health), the Ministry of Agriculture and the Land authorities, are intended to make more flexible the regulations governing fumigation of silos.

Special difficulties are met with in the control of mites in flour.

Denmark

Instances where control of pests in home-produced foods is difficult are rare. Owing to the climate, and rational storage of home-produced grain and other food and feeding stuffs, fumigation is rarely needed.

On the other hand, difficulties arise in connection with the fumigation of imported grain, as the stores in the Danish harbours were not built with a view to fumigation, and silo fumigation plants are not yet available.

Fumigation in the cold season is a specially difficult problem. On the farms, admixture with DDT is commonly used.

Sweden

The control of pests in bulk grain, stored on floors, is in many cases a technically difficult problem. The storehouses are usually not sufficiently airtight to permit the use of gases, such as HCN and methyl bromide. Admixture of contact insecticides, such as pyrethrum-piperonyl butoxide powders, with grain, is also accompanied by practical difficulties, if the quantities to be treated consist of deep and large stocks. There are also difficulties in treating grain during the filling of silo-tanks in obtaining a homogenous admixture of powder and grain.

MEDITERRANEAN GROUP

Yugoslavia

The fundamental reason why control of pests of stored products is so little practised in Yugoslavia is that the storage places are not adapted for the storage of agricultural produce and its derivatives. Chemical products are also lacking, and the price of those which are available is very high.

Preventive treatment is sometimes carried out by DDT liquid sprays, and disinfection with SO_2 and HCN.

No special experience with fumigation of cereals stored on floors or the admixture of insecticides. Quite a high proportion of seeds are disinfected.

Greece

Methyl bromide cannot be used for disinfecting cereals as the storage places are not sufficiently airtight. Neither is it used for storage boats, because of the difficulties in regard to proper ventilation of the grain after disinfection and the danger involved for men unloading the cargo.

For insects inside stores or on the surface of stored grain, sprays are satisfactorily used, either with 1 : 1000 lindane emulsion or a product containing pyrethrines and piperonyl butoxide (Pyrenones).

The use of dusts with a DDT or lindane base mixed with cereals to preserve them from insect attack, although effective, is not yet recommended for cereals intended for consumption, because no decision has yet been made on the question of toxicity for man and beast of the products of the grain thus treated. Further, there is never a certainty that the grain will be thoroughly washed before milling, which would free it of the greater part of the toxic matter. (The use of DDT or lindane dusts is, however, recommended for grain to be used for seed.)

The protection of rice presents no difficulties, since it is rarely seriously attacked by insects and is never stored for any length of time. If disinfection of rice is necessary, it is done in small chambers under atmospheric pressure with a mixture of three parts ethylene dichloride and one part carbon tetrachloride.

Algeria

Cf. p. 24.

Israel

No experience has been gained in this country with fumigation of bulk grain stored on floors. Insecticides are not mixed with grain or any other stored products destined for food for animals or humans. Some experiments have nevertheless been carried out to study the efficiency of non-toxic materials like Pyrenone and some inert dusts when mixed with grain in order to preserve feeding stuffs from insect pest attacks.

Stores containing bagged grain are fumigated with ethylene dibromide. This requires hermetically closed stores which have to be specially built at high cost. For this reason a method is being developed for fumigation under tarpaulin. Investigations are also being carried out into the absorption and residual toxicity of the fumigant in grain.

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